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This memorandum was prepared by the
Sub-Panel on General Purpose Analytic Equipment
of the NSASAB on 7 March 1955

1. The Sub-Panel on General Purpose Analytic Equipment has met twice for periods of several days at the Agency to review the development program of the Agency in this area and to try and formulate some comments and recommendations which may be helpful in extending our progress along these lines.

2. At the February meeting considerable emphasis was placed on the present state of the art and on the potentiality of achieving a very high speed arithmetic and logical unit in the milli-microsecond range. Dr. vonNeumann and others strongly urged an intensive research program in speed of components of this sort aimed at determining ultimate limits of the physical phenomena which are helpful to very high speed devices, such as the effective grain size and other physical limits. It was pointed out in particular while there are other groups in the government interested in this area that research of this type will not get itself automatically done and that the Agency appears to be the logical organization to initiate work in this area and that support might be secured from other sections of the Defense Department and the AEC if such a program were undertaken.

3. A general concept for a General Purpose Analytic Machine was set forth as a programmed-sequence-control machine incorporating

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ancillary units carrying out specific cryptologic operations or processes. In order to meet the wide variety of requirements in various types of work in the Agency it was felt that such a machine should have the capacity of modifying its instructions by a technique such as micro-programming which will permit the construction of new instructions which the machine can carry out after its completion and while it is in use. This would also permit the creating of complete instructions on what are essentially short high speed sub-routines which can be called into operation by a single instruction and applied repeatedly by a mechanism such as the 1103's repeat instruction.

4. A third requirement in the machine would be the development of some way of introducing a parallelism in the operation of various portions of the machine so that the quantity of work produced can approximate in some special cases that of special purpose analytic machines such as the comparators or the sled type machine.

5. It is felt that for this general area of machine operation a basically different logical organization from that of the customary electronic computer may be preferable. One point in particular in which there seems to be general agreement was that essentially all data processing and manipulation involves two streams of data and that the machine should be organized so that work can be effectively carried out on the basis from input through processing to output and the arithmetic unit be connected between the two streams and perhaps followed by a comparison device between the two streams. It is also

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felt that because of the nature of the work the machine should be fundamentally based on character-at-a-time operation with variable word, message, and record length so that a single instruction can call for the complete processing of an area of data corresponding to any one of these classes.

6. One very important general requirement is that special attention be given to the simplicity of programming the machine so that more one-time jobs can be undertaken by the programmers and even by the analysts as they encounter situations where a machine run may be useful.

7. In view of the status of the digital computer art at the present time as indicated by machines in use, it appears quite reasonable to set up standards for magnetic tape input and output operations of 50,000 characters per second; for an internal electronic character handling rate of one million characters per second; and for magnetic drum reading of 250,000 characters per second. These basic character rates can all be modified by paralleling to secure more favorable ratios between the various classes of data storage.

8. In accordance with the discussions led by Dr. vonNeumann we should certainly use the fastest possible speed in the central analytic unit and work out the necessary mechanism for combining this high speed unit with the slower memories which are all that are available at the present time.

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9. A discussion submitted at the last meeting with Mr. Snyder and Mr. Lathroun concerning the Farmer Project indicates that this program incorporates much of this thinking and is approaching a point where some definite design decisions can be made leading to the starting of a minimum system to which additional units can be added as developed. There is, however, a basic difference in that the Farmer system considers the individual analytic units as special machines which can be operated independently with separate input and output. The computer with its programmed sequence control is a vital but not essential one of the machines in the system. This in turn implies that the various machine units in the system have logical programming ability and that control would be passed from one machine to the next as it completed its work on some particular data. For instance, a minimum system might consist of input and output units, a modular arithmetic and a scoring unit, and this machine would be useful without the computer and its overall program control.

10. Because of a similarity between the Farmer Program and suggestions made by Panel Members in regard to the General Purpose Analytic Machine, it is strongly recommended that additional analytic and engineering effort be devoted to defining the elements of the Farmer System and to establishing design standards for the system and review of possible logical organizations of the computer and of the auxiliary units such as comparators, the recognition units, rotor analogs, etc., and in particular, that the set of instruc-

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tions particularly those which are peculiar to this work, be formulated for discussion and comparison with the most advanced digital computer machines.

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